

Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application.

1. (Previously Presented) A method implemented in an apparatus for reconstructing a first signal ( $x(t)$ ), the method comprising:

sampling a second signal ( $y(t)$ ) at a sub-Nyquist rate and at uniform intervals;

generating a set of sampled values ( $y_s[n], y(nT)$ ) from the second signal ( $y(t)$ );

retrieving from said set of sampled values a set of shifts ( $t_n, t_k$ ) and weights ( $c_n, c_{nr}, c_k$ );

and

reconstructing the first signal ( $x(t)$ ) based on the set of shifts ( $t_n, t_k$ ) and weights ( $c_n, c_{nr}, c_k$ );

2. (Original) Reconstruction method according to claim 1, wherein said set of regularly spaced sampled values comprises at least  $2K$  sampled values ( $y_s[n], y(nT)$ ),

wherein the class of said first signal ( $x(t)$ ) is known,

wherein the bandwidth ( $B, |\omega|$ ) of said first signal ( $x(t)$ ) is higher than  $\omega_m = \pi/T$ ,  $T$  being the sampling interval,

wherein the rate of innovation ( $\rho$ ) of said first signal ( $x(t)$ ) is finite,

wherein said first signal is faithfully reconstructed from said set of sampled values by solving a structured linear system depending on said known class of signal.

3. (Original) Reconstruction method according to claim 1, wherein the reconstructed signal

( $x(t)$ ) is a faithful representation of the sampled signal ( $y(t)$ ) or of a signal ( $x_i(t)$ ) related to said sampled signal ( $y(t)$ ) by a known transfer function ( $\phi(t)$ ).

4. (Original) Reconstruction method according to claim 3, wherein said transfer function ( $\phi(t)$ ) includes the transfer function of a measuring device (7, 9) used for acquiring said second signal ( $y(t)$ ) and/or of a transfer channel (5) over which said second signal ( $y(t)$ ) has been transmitted.

5. (Original) Reconstruction method according to claim 1, wherein the reconstructed signal ( $x(t)$ ) can be represented as a sequence of known functions ( $\gamma(t)$ ) weighted by said weights ( $c_k$ ) and shifted by said shifts ( $t_k$ ).

6. (Original) Reconstruction method according to claim 1, wherein the sampling rate is at least equal to the rate of innovation ( $\rho$ ) of said first signal ( $x(t)$ ).

7. (Original) Reconstruction method according to claim 1, wherein a first system of equations is solved in order to retrieve said shifts ( $t_k$ ) and a second system of equations is solved in order to retrieve said weights ( $c_k$ ).

8. (Original) Reconstruction method according to claim 7, wherein the Fourier coefficients ( $X[m]$ ) of said sample values ( $y_s[n]$ ) are computed in order to define the values in said first system of equations.

9. (Original) Reconstruction method according to claim 1, including the following steps:

finding at least  $2K$  spectral values ( $X[m]$ ) of said first signal ( $x(t)$ ),

using an annihilating filter for retrieving said arbitrary shifts ( $t_n, t_k$ ) from said spectral values ( $X[m]$ ).

10. (Original) Reconstruction method according to claim 1, wherein said first signal ( $x(t)$ ) is a periodic signal with a finite rate of innovation ( $\rho$ ).

11. (Original) Reconstruction method according to claim 10, wherein said first signal ( $x(t)$ ) is a periodical piecewise polynomial signal, said reconstruction method including the following steps:

finding  $2K$  spectral values ( $X[m]$ ) of said first signal ( $x(t)$ ),

using an annihilating filter for finding a differentiated version ( $x^{R+1}(t)$ ) of said first signal ( $x(t)$ ) from said spectral values,

integrating said differentiated version to find said first signal.

12. (Original) Reconstruction method according to claim 10, wherein said first signal ( $x(t)$ )

is a finite stream of weighted Dirac pulses  $(x(t) = \sum_{k=0}^{K-1} c_k \delta(t - t_k))$ , said reconstruction method

including the following steps:

finding the roots of an interpolating filter to find the shifts ( $t_n, t_k$ ) of said pulses, solving a linear system to find the weights (amplitude coefficients) ( $c_n, c_k$ ) of said pulses.

13. (Previously Presented) Reconstruction method according to claim 1, wherein said first signal ( $x(t)$ ) is a finite length signal with a finite rate of innovation ( $\rho$ ).

14. (Original) Reconstruction method according to claim 13, wherein said reconstructed signal ( $x(t)$ ) is related to the sampled signal ( $y(t)$ ) by a sinc transfer function ( $\phi(t)$ ).

15. (Original) Reconstruction method according to claim 13, wherein said reconstructed signal ( $x(t)$ ) is related to the sampled signal ( $y(t)$ ) by a Gaussian transfer function ( $\phi_\sigma(t)$ ).

16. (Original) Reconstruction method according to claim 1, wherein said first signal ( $x(t)$ ) is an infinite length signal in which the rate of innovation ( $\rho, \rho_T$ ) is locally finite, said reconstruction method comprising a plurality of successive steps of reconstruction of successive intervals of said first signal ( $x(t)$ ).

17. (Original) Reconstruction method according to claim 16, wherein said reconstructed signal ( $x(t)$ ) is related to the sampled signal ( $y(t)$ ) by a spline transfer function ( $\phi(t)$ ).

18. (Original) Reconstruction method according to claim 16, wherein said first signal ( $x(t)$ ) is a bilevel signal.

19. (Original) Reconstruction method according to claim 16, wherein said first signal ( $x(t)$ ) is a bilevel spline signal.

20. (Original) Reconstruction method according to claim 1, wherein said first signal ( $x(t)$ ) is a CDMA or a Ultra-Wide Band signal.

21. Cancelled.

22. (Currently Amended) A computer-readable medium on which is recorded a control program for a data processor, the computer-readable medium being program product encoded with instructions codes thereon executable by a digital processing system for causing the data processor to:

sample a first signal ( $y(t)$ ) at a sub-Nyquist rate and at uniform intervals;  
generate a set of sampled values ( $y_s[n]$ ,  $y(nT)$ ) from the first signal ( $y(t)$ );  
retrieve from said set of sampled values a set of shifts ( $t_n$ ,  $t_k$ ) and weights ( $c_n$ ,  $c_{nr}$ ,  $c_k$ ); and  
reconstruct a second signal ( $x(t)$ ) based on the set of shifts ( $t_n$ ,  $t_k$ ) and weights ( $c_n$ ,  $c_{nr}$ ,  $c_k$ ).

23. (Previously Presented) A method implemented in an apparatus for sampling a first signal ( $x(t)$ ), wherein said first signal ( $x(t)$ ) can be represented over a finite time interval ( $\tau$ ) by the superposition of a finite number ( $K$ ) of known functions ( $\delta(t)$ ,  $\gamma(t)$ ,  $\gamma_r(t)$ ) delayed by arbitrary shifts ( $t_n$ ,  $t_k$ ) and weighted by arbitrary amplitude coefficients ( $c_n$ ,  $c_k$ ), said method comprising:  
convoluting said first signal ( $x(t)$ ) with a sampling kernel (( $\phi(t)$ ,  $\phi(t)$ )) and using a regular sampling frequency ( $f$ ,  $1/T$ ),  
choosing said sampling kernel (( $\phi(t)$ ,  $\phi(t)$ )) and said sampling frequency ( $f$ ,  $1/T$ ) such that sampled values ( $y_s[n]$ ,  $y(nT)$ ) completely specify said first signal ( $x(t)$ ), and  
reconstructing said first signal ( $x(t)$ ),

wherein said sampling frequency ( $f$ ,  $1/T$ ) is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number ( $K$ ) divided by said finite time interval ( $\tau$ ).

24. (Original) Sampling method according to claim 23, wherein said first signal ( $x(t)$ ) is not bandlimited, and wherein said sampling kernel ( $\varphi(t)$ ) is chosen so that the number of non-zero sampled values is greater than  $2K$ .

25. (Previously Presented) An apparatus for reconstructing a first signal ( $x(t)$ ) from a set of sampled values ( $y_s[n]$ ,  $y(nT)$ ), comprising:

a sampling device configured to generate the set of sampled values ( $y_s[n]$ ,  $y(nT)$ ) via sampling a second signal ( $y(t)$ ) at a sub-Nyquist rate and at uniform intervals; and

a reconstruction device configured to retrieve from said set of sampled values a set of shifts ( $t_n$ ,  $t_k$ ) and weights ( $c_n$ ,  $c_{nr}$ ,  $c_k$ ) with which said first signal ( $x(t)$ ) can be reconstructed.

26. (Previously Presented) The apparatus according to claim 25, wherein said set of regularly spaced sampled values comprises at least  $2K$  sampled values ( $y_s[n]$ ,  $y(nT)$ ), wherein the class of said first signal ( $x(t)$ ) is known, wherein the bandwidth ( $B$ ,  $|\omega|$ ) of said first signal ( $x(t)$ ) is higher than  $\omega_m = \pi/T$ ,  $T$  being the sampling interval, wherein the rate of innovation ( $\rho$ ) of said first signal ( $x(t)$ ) is finite, and wherein said first signal is faithfully reconstructed from said set of sampled values by solving a structured linear system depending on said known class of signal.

27. (Previously Presented) The apparatus according to claim 25, wherein the reconstructed signal ( $x(t)$ ) is a faithful representation of the sampled signal ( $y(t)$ ) or of a signal ( $x_i(t)$ ) related to said sampled signal ( $y(t)$ ) by a known transfer function ( $\phi(t)$ ).

28. (Previously Presented) The apparatus according to claim 27, wherein said transfer function ( $\phi(t)$ ) includes the transfer function of a measuring device (7, 9) used for acquiring said second signal ( $y(t)$ ) and/or of a transfer channel (5) over which said second signal ( $y(t)$ ) has been transmitted.

29. (Previously Presented) The apparatus according to claim 25, wherein the reconstructed signal ( $x(t)$ ) can be represented as a sequence of known functions ( $\gamma(t)$ ) weighted by said weights ( $c_k$ ) and shifted by said shifts ( $t_k$ ).

30. (Previously Presented) The apparatus according to claim 25, wherein the sampling rate is at least equal to the rate of innovation ( $\rho$ ) of said first signal ( $x(t)$ ).

31. (Previously Presented) The apparatus according to claim 25, wherein a first system of equations is solved in order to retrieve said shifts ( $t_k$ ) and a second system of equations is solved in order to retrieve said weights ( $c_k$ ).

32. (Previously Presented) The apparatus according to claim 31, wherein the Fourier coefficients ( $X[m]$ ) of said sample values ( $y_s[n]$ ) are computed in order to define the values in

said first system of equations.

33. (Previously Presented) The apparatus according to claim 25, further comprising:  
a filter configured to find at least 2K spectral values (X[m]) of said first signal (x(t)); and  
an annihilating filter configured to retrieve said arbitrary shifts (t<sub>n</sub>, t<sub>k</sub>) from said spectral values (X[m]).

34. (Previously Presented) The apparatus according to claim 25, wherein said first signal (x(t)) is a periodic signal with a finite rate of innovation (p).

35. (Previously Presented) The apparatus according to claim 34, wherein said first signal (x(t)) is a periodical piecewise polynomial signal, the apparatus further comprising:  
a filter configured to find 2K spectral values (X[m]) of said first signal (x(t));  
an annihilating filter configured to find a differentiated version (x<sup>R+1</sup>(t)) of said first signal (x(t)) from said spectral values; and  
an integrator configured to integrate said differentiated version to find said first signal.

36. (Previously Presented) The apparatus according to claim 34, wherein said first signal (x(t)) is a finite stream of weighted Dirac pulses ( $x(t) = \sum_{k=0}^{K-1} c_k \delta(t - t_k)$ ), the apparatus further comprising:  
a filter configured to find the roots of an interpolating filter to find the shifts (t<sub>n</sub>, t<sub>k</sub>) of said pulses, and solve a linear system to find the weights (c<sub>n</sub>, c<sub>k</sub>) of said pulses.

37. (Previously Presented) The apparatus according to claim 25, wherein said first signal ( $x(t)$ ) is a finite length signal with a finite rate of innovation ( $\rho$ ).

38. (Previously Presented) The apparatus according to claim 37, wherein said reconstructed signal ( $x(t)$ ) is related to the sampled signal ( $y(t)$ ) by a sinc transfer function ( $\phi(t)$ ).

39. (Previously Presented) The apparatus according to claim 37, wherein said reconstructed signal ( $x(t)$ ) is related to the sampled signal ( $y(t)$ ) by a Gaussian transfer function ( $\phi_\sigma(t)$ ).

40. (Previously Presented) The apparatus according to claim 25, wherein said first signal ( $x(t)$ ) is an infinite length signal in which the rate of innovation ( $\rho, \rho_T$ ) is locally finite, wherein the reconstruction device is further configured to reconstruct successive intervals of said first signal ( $x(t)$ ).

41. (Previously Presented) The apparatus according to claim 40, wherein said reconstructed signal ( $x(t)$ ) is related to the sampled signal ( $y(t)$ ) by a spline transfer function ( $\phi(t)$ ).

42. (Previously Presented) The apparatus according to claim 40, wherein said first signal ( $x(t)$ ) is a bilevel signal.

43. (Previously Presented) The apparatus according to claim 40, wherein said first signal ( $x(t)$ ) is a bilevel spline signal.

44. (Previously Presented) The apparatus according to claim 25, wherein said first signal ( $x(t)$ ) is a CDMA or a Ultra-Wide Band signal.

45. (Previously Presented) An apparatus for reconstructing a first signal ( $x(t)$ ) from a set of sampled values ( $y_s[n]$ ,  $y(nT)$ ), comprising:

means for generating the set of sampled values ( $y_s[n]$ ,  $y(nT)$ ) by sampling a second signal ( $y(t)$ ) at a sub-Nyquist rate and at uniform intervals; and

means for retrieving from said set of sampled values a set of shifts ( $t_n$ ,  $t_k$ ) and weights ( $c_n$ ,  $c_{nr}$ ,  $c_k$ ) with which said first signal ( $x(t)$ ) can be reconstructed.

46. (Previously Presented) An apparatus for sampling a first signal ( $x(t)$ ), wherein said first signal ( $x(t)$ ) can be represented over a finite time interval ( $\tau$ ) by the superposition of a finite number (K) of known functions ( $\delta(t)$ ,  $\gamma(t)$ ,  $\gamma_r(t)$ ) delayed by arbitrary shifts ( $t_n$ ,  $t_k$ ) and weighted by arbitrary amplitude coefficients ( $c_n$ ,  $c_k$ ), said method comprising:

a filter configured to convolute said first signal ( $x(t)$ ) with a sampling kernel (( $\phi(t)$ ,  $\phi(t)$ )) and using a regular sampling frequency ( $f$ ,  $1/T$ );

a sampling device configured to choose said sampling kernel (( $\phi(t)$ ,  $\phi(t)$ )) and said sampling frequency ( $f$ ,  $1/T$ ) such that the sampled values ( $y_s[n]$ ,  $y(nT)$ ) completely specify said first signal ( $x(t)$ ); and

a reconstruction device configured to reconstruct said first signal ( $x(t)$ ),  
wherein said sampling frequency ( $f$ ,  $1/T$ ) is lower than the frequency given by the  
Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite  
time interval ( $\tau$ ).

47. (Previously Presented) The apparatus according to claim 46, wherein said first signal ( $x(t)$ ) is not bandlimited, and wherein said sampling kernel ( $\phi(t)$ ) is chosen so that the number of non-zero sampled values is greater than  $2K$ .

48. (Currently Amended) A computer-readable medium on which is recorded a control program for a data processor, the computer-readable medium being program product encoded with instructions codes thereon executable by a digital processing system for causing the data processor to:

sample a first signal ( $x(t)$ ), wherein said first signal ( $x(t)$ ) can be represented over a finite time interval ( $\tau$ ) by the superposition of a finite number ( $K$ ) of known functions ( $\delta(t), \gamma(t), \gamma_r(t)$ ) delayed by arbitrary shifts ( $t_n, t_k$ ) and weighted by arbitrary amplitude coefficients ( $c_n, c_k$ );

convolute said first signal ( $x(t)$ ) with a sampling kernel (( $\phi(t), \psi(t)$ )) and using a regular sampling frequency ( $f, 1/T$ );

choose said sampling kernel (( $\phi(t), \psi(t)$ )) and said sampling frequency ( $f, 1/T$ ) such that the sampled values ( $y_s[n], y(nT)$ ) completely specify said first signal ( $x(t)$ ); and reconstruct said first signal ( $x(t)$ ),

wherein said sampling frequency ( $f, 1/T$ ) is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number ( $K$ ) divided by said finite time interval ( $\tau$ ).

49. (Previously Presented) An apparatus for sampling a first signal ( $x(t)$ ), wherein said first signal ( $x(t)$ ) can be represented over a finite time interval ( $\tau$ ) by the superposition of a finite

number (K) of known functions ( $\delta(t)$ ,  $\gamma(t)$ ,  $\gamma_r(t)$ ) delayed by arbitrary shifts ( $t_n$ ,  $t_k$ ) and weighted by arbitrary amplitude coefficients ( $c_n$ ,  $c_k$ ), said method comprising:

means for convoluting said first signal ( $x(t)$ ) with a sampling kernel (( $\phi(t)$ ,  $\phi(t)$ ) and using a regular sampling frequency ( $f$ ,  $1/T$ );

means for choosing said sampling kernel (( $\phi(t)$ ,  $\phi(t)$ ) and said sampling frequency ( $f$ ,  $1/T$ ) such that the sampled values ( $y_s[n]$ ,  $y(nT)$ ) completely specify said first signal ( $x(t)$ ); and means for reconstructing said first signal ( $x(t)$ ),

wherein said sampling frequency ( $f$ ,  $1/T$ ) is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite time interval ( $\tau$ ).